Commonwealth Edison Company
Byron Generating Station
4450 North German Church Road
Byron, IL 61010-9794
Tel 815-234-5441

ComEd

November 4, 1997

LTR: BYRON 97-0253
FILE: 3.03.0800 (1.10.0101)

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Dear Sir:

The Enclosed Licensee Event Report from Byron Generating Station is being transmitted to you in accordance with the requirements of 10CFR50.73(a)(2)(iv).

This report is number 97-003; Docket No. 50-455.

Sincerely,

K. L. Kofron
Station Manager
Byron Nuclear Power Station

KLK/MS/js

IE22 1/1

Enclosure: Licensee Event Report No. 97-003

cc: A. B. Beach, NRC Region III Administrator
NRC Senior Resident Inspector
INPO Record Center
ComEd Distribution List

(p:\regassur\pifler\ler\wp9565r.wpf\102997)

CATEGORY 1

REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR:9711100093 DOC.DATE: 97/11/04 NOTARIZED: NO DOCKET #
FACIL:STN-50-455 Byron Station, Unit 2, Commonwealth Edison Co. 05000455
AUTH.NAME AUTHOR AFFILIATION
QUIGLEY,B. Commonwealth Edison Co.
KOFRON,K.L. Commonwealth Edison Co.
RECIP.NAME RECIPIENT AFFILIATION

SUBJECT: LER 97-003-00:on 971010,reactor trip occurred,due to age-related failures of redundant power supplies that went undetected by alarm sys.Modification to power supply failure alarm will be submitted to TRC for review.W/971104 ltr.

DISTRIBUTION CODE: IE22T COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 6
TITLE: 50.73/50.9 Licensee Event Report (LER), Incident Rpt, etc.

NOTES:Standardized Plant. 05000455

	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL
	PD3-2 PD	1	1	DICK,G	1	1
INTERNAL:	ACRS	1	1	AEOD/SPD/RAB	2	2
	AEOD/SPD/RRAB	1	1	FILE CENTER	1	1
	NRR/DE/ECGB	1	1	NRR/DE/EELB	1	1
	NRR/DE/EMEB	1	1	NRR/DRCH/HHFB	1	1
	NRR/DRCH/HICB	1	1	NRR/DRCH/HOLB	1	1
	NRR/DRCH/HQMB	1	1	NRR/DRPM/PECB	1	1
	NRR/DSSA/SPLB	1	1	NRR/DSSA/SRXB	1	1
	RES/DET/EIB	1	1	RGN3 FILE 01	1	1
EXTERNAL:	L ST LOBBY WARD	1	1	LITCO BRYCE,J H	1	1
	NOAC POORE,W.	1	1	NOAC QUEENER,DS	1	1
	NRC PDR	1	1	NUDOCS FULL TXT	1	1

I C C U M E N T

NOTE TO ALL "RIDS" RECIPIENTS:
PLEASE HELP US TO REDUCE WASTE. TO HAVE YOUR NAME OR ORGANIZATION REMOVED FROM DISTRIBUTION LISTS OR REDUCE THE NUMBER OF COPIES RECEIVED BY YOU OR YOUR ORGANIZATION, CONTACT THE DOCUMENT CONTROL DESK (DCD) ON EXTENSION 415-2083

FULL TEXT CONVERSION REQUIRED
TOTAL NUMBER OF COPIES REQUIRED: LTTR 25 ENCL 25

1122

NRC FORM 366 (4-95) U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104 EXPIRES 04/30/98
LICENSEE EVENT REPORT (LER) (See reverse for required number of digits/characters for each block)	ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
BYRON NUCLEAR POWER STATION, UNIT 2	05000455	1 OF 5

TITLE (4)

Reactor Trip Due to Age-Related Failures of Redundant Rod Drive Power Supplies

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
10	10	97	97	-- 003 --	00	11	04	97		05000
									FACILITY NAME	DOCKET NUMBER 05000

OPERATING MODE (9)	1
POWER LEVEL (10)	099

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

	20.2201(b)		20.2203(a)(2)(v)		50.73(a)(2)(i)		50.73(a)(2)(viii)
	20.2203(a)(1)		20.2203(a)(3)(i)		50.73(a)(2)(ii)		50.73(a)(2)(x)
	20.2203(a)(2)(i)		20.2203(a)(3)(ii)		50.73(a)(2)(iii)		73.71
	20.2203(a)(2)(ii)		20.2203(a)(4)	X	50.73(a)(2)(iv)		OTHER
	20.2203(a)(2)(iii)		50.36(c)(1)		50.73(a)(2)(v)		Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iv)		50.36(c)(2)		50.73(a)(2)(vii)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Barry Quigley, Root Cause Analyst	815-234-5441 X2487

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS
X	AA	RJX	L045	Y						

SUPPLEMENTAL REPORT EXPECTED (14)			EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
	YES (If yes, complete EXPECTED SUBMISSION DATE).	X NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

A Unit 2 reactor trip occurred at 1112 on 10/10/97 following the failure of redundant Rod Drive Power cabinet power supplies. One or more rods fell into the core, causing a trip on high negative flux rate.

The day before, a local Power Supply Failure alarm was noted. Troubleshooting on the day of the trip found voltage on both supplies dropping. As an attempt was being made to install a temporary supply, the conditions finally reached the point where one or more gripper coils released their respective rods.

Testing of all Rod Drive power supplies found 4 more failures between both units. The average age of all failed supplies was 76 months. A search of Operating Experience only found one occurrence relating to age concerns of Lambda power supplies. This was a 1995 report stating a 5 year life for Lambda power supplies. Pending confirmation from offsite testing, the failure of the power supplies is age-related.

A contributor was the failure of the alarm to annunciate the first power supply failure. This vulnerability was pointed out in a 1987 vendor bulletin. Due to the low failure rate in 1987, the station chose to inspect the power supplies instead of modifying the alarm circuit.

Corrective actions will be to periodically replace the power supplies and evaluate changes to the alarm circuit. This event is reportable per 10CFR50.73(a)(2)(iv).

A. PLANT CONDITIONS PRIOR TO EVENT:

Event Date/Time 10-10-97 / 1112

Unit 1 Mode - 3 Hot Standby Rx Power 0% RCS [AB] Temperature/Pressure NOT/NOP

Unit 2 Mode - 1 Power Operation Rx Power 99% RCS [AB] Temperature/Pressure NOT/NOP

B. DESCRIPTION OF EVENT:

At 1039 on 10/9/97, a Rod Control Non-Urgent alarm toggled repeatedly on Unit 2. The auxiliary operator that investigated the alarm on the morning of 10/10/97 found the power supply failure light lit on a Rod Drive [AA] Power Cabinet. Troubleshooting on 10/10/97 found that the control room alarm had cleared but the local alarm was still lit and voltages had dropped by 3 volts to -14.8VDC in about 90 minutes. It was also noted that DC bus voltage ripple was excessive and that one of the power supplies (PS3) was cool to the touch.

Based on the data, conversations with the Rod Drive System Engineer, and just received information from the vendor that rods would drop at about -13VDC, it was decided to install a temporary power supply to allow time for more permanent repairs. As the temporary power supply was being connected, an automatic reactor trip occurred. As expected for normal post-trip response, an automatic start (ESF actuation) of the AF pumps occurred on low SG level.

The actions of 2BEP-0, Reactor Trip or Safety Injection, were successfully completed.

One anomaly after the trip was a spurious Containment Ventilation Isolation signal, all equipment operated by this signal was already in the actuated condition.

Other than the first failed power supply, no other components were inoperable prior to the event that contributed to the event.

C. CAUSE OF EVENT:

The trip was caused by probable age related failures of redundant power supplies that went undetected by the alarm system.

Some time after October 1996 (the last time the power supplies were tested), the first power supply, PS3, failed. This shifted the entire load to the redundant power supply, PS4. On 10/9/97, PS4 began failing as indicated by the toggling of the Rod Drive Non-Urgent Failure alarm and the local power supply failure alarm. Conditions eventually degraded to the point where the gripper coils were unable to hold onto the rods. This caused a high negative flux rate trip.

C. CAUSE OF EVENT (cont.)

Power Supply Failure Analysis:
Eight power supply failures were evaluated: the two that caused the trip, an additional four found during troubleshooting and two other recent failures found during work history review. A structured approach was used to evaluate possible failure modes and commonalties between failed power supplies. These included: power supply age, cabinet cooling supply arrangement, differences in AC power sources to the power supplies, and small differences in power supply characteristics. Based on the average age of the failed power supplies being 76 months, a mean time between failure of 60 months (OE 7043) and elimination of other causes, the probable cause of the power supply failures is age-related degradation. To preserve evidence for further inspection, the power supplies were not disassembled for internal examination. The two failed power supplies from the event were sent to the Company's Material Engineering Group for confirmation of age-related failure.

Alarm Failure Analysis:
A contributor to the event was the failure of the power supply to alarm when the first power supply failed. The alarm looks for a 4 volt difference between power supply outputs. Since the supplies were failing in a mode where they could produce voltage but not carry load, the alarm did not come in when the first power supply failed. The alarm toggling on 10/9/97 was due to the second power supply failure. Note that at the time of the trip, the Rod Drive Non-Urgent Failure alarm was not lit, even though voltage was substantially below normal. This is the failure mode discussed in a 1987 vendor bulletin.

Elimination of possible contributors:

Hookup of Temporary Power Supply:
The reactor trip occurred as the second connection of the temporary power supply was being made. Several causes, including technician error and electrical transients were considered.

Post event testing and interviews found that the polarity arrangement of the power supply was correct and the connection points were proper.

A small arc was observed when the second power supply connection was made at the time of the trip. During testing, a small arc was drawn repeatedly while hooking up the temporary power supply. Review of the strip chart recorder showed no voltage spikes.

Another scenario was that the temporary power supply reverse biased the isolation diode on the only remaining power supply, essentially shutting it off. If the temporary power supply were not able to immediately handle the load, the voltage may have decreased causing the trip. Review of strip charts from testing showed that the temporary power supply immediately picked up the load.

The last scenario considered was that the rapid voltage rise from hooking up the temporary power supply (12VDC over 150 milliseconds) caused some perturbation in the rod control circuitry, resulting in dropping a control rod. The rapid voltage rise was duplicated by the vendor on the Rod Control Training Simulator and did not cause any problems.

C. CAUSE OF EVENT (cont.)

Finally, in 1989 a temporary power supply was successfully used in place of one of the redundant power supplies with no problems.

Based on the elimination of probable causes, previous success with a temporary power supply, and the continuing degradation of voltage, the installation of the temporary power supply was ruled out as a contributor to the trip. After considering possible causes, it is concluded that voltage finally reached the minimum acceptable value as the technicians were hooking up the power supply.

Review of Operating Experience (OPEX):
Westinghouse issued Tech Bulletin NSID-TB-87-010 that described Lambda power supplies failures where they were unable to carry load but still produce voltage. For these cases the low voltage alarm would not come up. Two options were provided. The first was to install a resistor to ground such that the power supply was always loaded to 10% load. This would ensure that voltage would be pulled down to the alarm setpoint if the power supply failed. The second option was to inspect the power supplies. The inspection option was selected since at the time the bulletin was issued the failure rate was low. Note that the inspection procedure used was adequate because it was able to detect the additional failures found during post event testing. The response to the Westinghouse Bulletin was adequate.

An INPO Operating Experience (OE) from 1995 (OE 7043), "Electricians Cause C Bus Lockout", describes a case where human error caused the loss of a Non-ESF bus resulting in the loss of a Rod Drive power supply. The redundant power supply had previously failed and was not detected by the alarm circuit. The trip occurred because both power supplies were lost - the first was lost due to an undetected failure and the second due to loss of input power. The OE states that failure "appears to be age-related" and goes on to say that "The power supply is manufactured by Lambda Electronics with an expected mean time between failures of five years." Conversations with the vendor on expected power supply life during the current investigation were ambiguous.

D. SAFETY ANALYSIS:

Both the dropped control rod and subsequent reactor trip are analyzed and bounded by the Final Safety Analysis Report (FSAR). This Condition II event is shown in the FSAR to not impact the health and safety of the public.

Only one other reasonable condition was postulated under which the event might have proceeded differently. This is to postulate a rod misalignment during rod movement. The rods fed from the affected power cabinet are in Shutdown Bank C, D and E and are only moved during startup, shutdown and monthly rod exercising. Had the reduced voltage caused rod misalignment during these infrequent events, existing abnormal operating procedures are adequate to address the condition.

E. CORRECTIVE ACTIONS:

To prevent future age-related failures of rod drive power supplies:

Engineering will provide a suitable frequency for Rod Drive Power cabinet power supply replacement. (455-180-97-SCAQ00003-01)

Instrument Maintenance will establish a PM to replace the power supplies on the frequency established by Engineering (455-180-97-SCAQ00003-02)

To detect future power supply failures:

A modification to the power supply failure alarm will be submitted to the Technical Review Committee for review and prioritization. (NTS 455-180-97-SCAQ00003-03)

ADDITIONAL ACTIONS:
A significant contributor was the failure of the alarm circuit to signal a failure of a power supply. Other important systems with redundant power supplies may share this vulnerability. To identify if this is the case, System Engineering will review critical systems and determine if probable power supply failures could go undetected. (NTS 455-180-97-SCAQ00003-04)

F. RECURRING EVENTS SEARCH AND ANALYSIS:

Other reactor trips have occurred as a result of power supply problems caused by lightning strikes. There have been no previous reactor trips as a result of age-related failures of power supplies.

G. COMPONENT FAILURE DATA:

MANUFACTURER	NOMENCLATURE	MODEL NUMBER	MFG PART NUMBER
Lambda	Negative 24 Volt Power Supply	LCS-A-24-6795	N/A